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EFFECTIVENESS OF KINESIOTAPING AS AN THERAPY TO IMPROVE DYSGRAPHIA IN CHILDREN WITH HEMIPLEGIC CEREBRAL PALSY

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ABSTRACT

Background: Studies have reported that the upper limb in cerebral palsy features a functionless hand, exhibited as a flexed elbow with pronated forearm and flexed wrist and fingers with spasticity and weakness, thumb in adduction and loss of sensation and proprioception. An alternative approach without compromising the child's ability to move freely and without limiting the sensori motor experiences would be to use the kinesiotape, which allows free movement and encourages a relaxation of soft tissue with improvement in lymphatic flow, thereby reducing pain and swelling. The elastic properties of the kinesiotape provides support and helps to reduce muscle fatigue. This study was a preliminary attempt to assess the effectiveness of Kinesiotaping as an adjunctive therapy to improve dysgraphia in children with hemiplegic cerebral palsy. The results of our study showed a strongly significant difference of p value for the word component, letter component and the numeral component between the scores of the children, who received Kinesiotaping as an adjunctive therapy and the children who did not receive Kinesiotaping and indicate that the children who received Kinesiotaping as an adjunctive therapy wrote more legibly at the end of two weeks.

KEYWORDS: Cerebral Palsy, Kinesiotaping, handwriting & dysgraphi

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Original Article

INTRODUCTION

"Cerebral palsy describes a group of permanent disorders of the development of movement and posture, which cause activity limitation. These disorders are caused by non-progressive disturbances to the developing foetal or infant brain. The motor disorders of cerebral palsy are often accompanied by disturbances of sensation, perception, cognition, communication, behaviour, by epilepsy and by secondary musculoskeletal problems". [I]

The main feature of cerebral palsy is abnormal motor behavior (reflecting abnormal motor control). "It is characterized by various abnormal patterns of movement and posture caused by defective coordination of movements and/or regulation of muscle tone. The patients with cerebral palsy may also exhibit neuro developmental impairments that can affect adaptive functioning, sensory functioning, learning, communication and behaviour as well as seizures".

"Hemiplegic cerebral palsy is caused by early brain damage, including brain malformations, periventricular brain lesions, middle cerebral artery infarctions, and non-progressive postnatal brain injuries. As a result, the movement impairments are largely lateralized to one side with the upper extremity usually being affected more than the lower extremity. Along with this, the integrity of the motor cortex and corticospinal pathways, essential for precision grasping and fine control of the fingers and hand are compromised. [II] Consequently, skilled, independent finger movements and hand skills do not develop normally. The involved upper extremity exhibits abnormal muscle

tone with wrist in flexion, ulnar deviation, elbow flexion and shoulder internal or external rotation[III]. The fine motor skills may also be affected due to reduced strength as well as tactile and proprioceptive disturbances. Brain damage associated with hemiplegia often includes areas that are involved in bimanual coordination, such as the supplementary motor area and the parietal lobe". [IV]

The treatment for cerebral palsy focuses on how to help the individual maximize his or her potential.[V] Physiotherapy for children with cerebral palsy typically includes facilitation of motor development and enhancement of independence in motor skills, self-care, play and leisure activities. Research has led to the development of many systems of treatment (e.g., neuro developmental therapy, the Vojta method, conductive education, sensory integrative therapy, constraint-induced movement therapy, etc). These systems of treatment differ in their specific treatment strategies, but are aimed at leading children with cerebral palsy towards the greatest degree of independence possible.

"Handwriting is a complex activity in which there is continuous interaction between lower-level perceptual-motor processes and higher-level cognitive processes. When a child wants to write, he or she first has to retrieve the correct letters or words from memory, put them in the right order and convert phonemes into graphemes (higher level processes) before the corresponding motor program can be selected and executed (lower level processes). Perceptual motor processes in handwriting consist of perception of either visual (e.g., copying text) or auditory (e.g., dictation/information), fine motor coordination (in-hand manipulation, bilateral integration) and visual-motor integration (e.g., hand-eye coordination). Cognitive processes involved in handwriting can be divided in more generic processes like cognitive planning or working memory processes, and more specific language processes, such as phonological and orthographic coding. Problems in handwriting relate to a deficit in perceptual-motor function" [VI].

"Legibility and speed are the two most important elements in handwriting performance. Handwriting legibility may be affected by difficulties with letter formation, spacing, size, slant, and/or alignment [VII].

Hamstra-Bletz and Blote defined dysgraphia as a disturbance or difficulty in the production of written language that has to do with the mechanics of writing. [VIII] Estimates of handwriting dysfunction in children range from 10 to 34%" [IX].

"Impairment in proprioception seen in the non-hemiplegic side in children with cerebral palsy, and also the impairment in bilateral coordination, speed and dexterity of the upper extremities, visual and spatial perception, visual-motor organization and tactile-sensory impairments negatively affected their handwriting skills [X]. The fact that the hand function is controlled by the cortical spinal tract and that although only one side of the body is affected, there might be a cortical lesion that affects the dexterity and coordination of the unaffected hand, explains this phenomenon". [XI]

Kinesiotaping is a patient-friendly treatment that will help the pediatric patient with muscle imbalance resulting from neurological conditions, by stimulating weak muscles and relaxing overused muscles. The use of taping along with the child's regular therapy program like cryotherapy, hydrotherapy, manual therapy, electro-stimulation, etc., may favorably influence the cutaneous receptors of the sensorimotor system that results in subsequent improvement of voluntary control and coordination of the upper limb.[XII] Theoretically, when the tape is applied properly, it can strengthen the weakened muscles, control joint instability, assist with postural alignment and relax an overused muscle. The purpose of taping is to improve the dynamic stability of the weak muscles or the painful muscles, by improving alignment and cutaneous stimulation to enhance the muscle contraction. [XIII]

"Research has shown that children spend quarter to half of their classroom time involved with paper and pencil tasks everyday at school.[XIV] When thermoplastic orthotic devices are applied, they may allow the child to gain control over movements without the presence of the therapist. The action of this rigid orthotic intervention is through the biomechanical principles to reduce the degree of freedom (where learning must take place simultaneously), control postural alignment, prevent deformity and improve function"[XV], but it sacrifices the child's ability to move freely and limits the child's sensorimotor experiences for motor learning. Dynamic bracing helps to overcome these problems, but dynamic bracing is expensive and not accommodative to the child's growth [XVI]. An alternative approach would be the use of kinesiotape which is 100% cotton. The thickness and weight of the tape is approximately that of the skin. Hence, it is tolerated by most patients. The tape also allows movement. The tape helps to encourage relaxation of soft tissues and improves lymphatic flow, thereby reducing pain and swelling. The elastic properties of the tape provides support and helps to reduce muscle fatigue[XVII]. These are the reasons that led to the need of our study.

"The main objectives of the study were:

- To find the effect of Conventional Therapy in increasing the handwriting scores to improve dysgraphia in children with hemiplegic cerebral palsy.
- To find the effect of Kinesiotaping along with Conventional Therapy in increasing the handwriting scores to improve dysgraphia in children with hemiplegic cerebral palsy.
- To compare the effectiveness of Kinesiotaping over conventional physiotherapy in increasing the handwriting scores to improve dysgraphia in children with hemiplegic cerebral palsy".

STUDY DESIGN

This study was an experimental study design with a control group involving the pre and post analysis of data.

STUDY SETTING

This study was conducted in St. Johns Medical College and Hospital, Bangalore.

SAMPLE SELECTION

Forty subjects aged between 6 and 8 years with hand dysfunction resulting from cerebral palsy with hemiplegia were selected by means of simple random sampling and were divided into two groups, namely, Group I and Group II with 20 subjects each. All the subjects were included in the study after the informed consent form was signed by the parent/caregiver. The purpose of the study was clearly explained to the parent/caregiver.

SELECTION CRITERIA

Inclusion Criteria

- Children diagnosed with hand dysfunction resulting from cerebral palsy with hemiplegia having limited hand function were assessed using Quality of Upper Extremity Skills Test (QUEST).[XVIII]
- Both male and female children.
- Children aged between 6 and 8 years.

Exclusion Criteria

- Children with cognitive or perceptual deficit
- Children with epilepsy
- Children with visual deficits
- Children with severe spasticity of upper limb
- Children with emotional and behavioral problems

MATERIALS USED

- Evaluation Tool of Children's Handwriting(ETCH)
- 2 HB pencils
- Kinesio Tex Tape

Measurement Tools

"ETCH: Evaluation Tool of Children's Handwriting contains 7 cursive writing tasks and 6 manuscript writing tasks plus items addressing the child's ability to handle the writing tool and paper. It assesses word, letter and numeral legibility and speed".

$$\text{Letter legibility} = \frac{\text{Number of legible letters}}{\text{Number of total possible letters}} \times 100$$

$$\text{Word legibility} = \frac{\text{Number of legible words}}{\text{Number of total possible words}} \times 100$$

Numeral legibility:-

20 – 100%,.....1-5%, 0-0%

$$\text{Legibility percentage} = \frac{\text{Correct words/letters}}{\text{Total words/letters}} \times 100$$

Speed = number of words or letters/minute.

PROCEDURE

The subjects were randomly allotted into two equal groups consisting of 20 subjects each, namely, Group-I and Group-II. The caregivers were informed about the treatment procedure before assessment.

Group-I (Control Group) received the Conventional Physiotherapy that they were regularly receiving. The Conventional Physiotherapy involved development of fine motor skills for good hand function with various activities and incorporating all these activities into the instrumental activities of daily living like writing. The activities for improving the fine motor skills included activities to improve the bilateral shoulder stability (activities like prone lying, prone on elbows, prone on hand, weight bearing, stretching, etc.), activities to improve bilateral co-ordination (activities like moving both hands against gravity in sitting, holding objects with both hands, activities with rolled towel between the scapula in the supine position to improve co-ordination with bilateral shoulder protraction, reflex inhibitory patterns, etc.) and activities

to improve sensation (activities to improve tactile sensitivity with desensitization techniques, like use of theraputty, wet mud, spike balls, soft and coarse Materials, etc.).

Group-II (Experimental Group) received the Conventional Physiotherapy that they were regularly receiving, as mentioned above. In addition to the conventional therapy, they received taping as follows: At rest, the forearm is in pronation, with the wrist flexed and thumb adducted.

The muscle imbalance prevented the thumb from actively extending or abducting at the MCP and IP joints. There is tightness and atrophy in the thenar eminence and the child often has difficulty with palmar expansion. A tape was applied to assist with thumb extension. To apply the tape, the thumb was positioned in extension. The tape was anchored at the thumb IP joint. Maintaining the thumb in extension, the proximal anchor of tape was applied to middle third of interosseous membrane, on the dorsal surface of forearm. The thumb was flexed as the tape was rubbed down over the thumb and the dorsum of the forearm.[XIII]

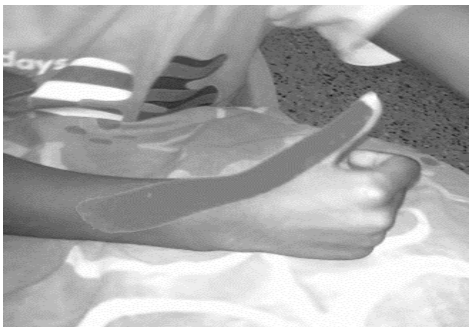


Figure 1: Tape to Assist with Thumb Extension.

For metacarpophalangeal joint instability, an "I" tape was placed to support the joint. An "I" strip was measured around the thumb. The tape in the center was torn and folded back. The tape was applied with minimal-to-moderate tension with the MCP joint in slight flexion. Care was taken that the taping technique does not restrict circulation[XIII]

To improve palmar expansion, a tape was measured from the proximal carpometacarpal joint along the thenar eminence up through the web space and back around the dorsal side, connecting the beginning of the tape. The tape was anchored at the proximal CMC joint. Paper-off tension was applied into the thenar eminence with the hand in a fully opened position. The paper-off tension was continued up through the web space and on the dorsum of the hand back to the CMC joint[XIII]



Figure 2: Tape to Improve Palmar Expansion.

A tape was applied to assist with wrist extension. The tape length was measured from the metacarpals to the

lateral epicondyle. The wrist was extended and the anchor was applied on the dorsum of the hand, over the metacarpals. Maintaining the wrist in extension, the proximal anchor of the tape was applied on the lateral epicondyle, leaving a space between the tape and forearm. The wrist was flexed as the tape was rubbed down over the dorsum of the forearm. The tape was assisted with active wrist extension[XIII].



Figure 3: Tape to Assist with Wrist Extension.

Taping for palmar stability provides the proprioceptive input of stabilizing and facilitating fine finger movements. The tape length was measured from the palm through the web space to the third metacarpal. The tape was "Y" cut with 50% anchor and 50% tails. The hand was positioned in neutral deviation and the wrist was in 20^0 extension. The tape was anchored within the palmar arch. The tape was applied with paper-off tension through web space. The tails of the tape was applied over the dorsum of the hand with paper-off tension in a diagonal direction.[XIII]



Figure 4: Tape to Improve Palmar Stability.

Both the groups were assessed using the Evaluation Tool for Children's Handwriting[XIX] in both the manuscript and cursive aspects prior to starting the therapy, and at two weeks from the starting of the therapy, i.e., to the end of the therapy session. "It is designed for use with 6-year-old to 12 year olds and is composed of assessments for two types of handwriting: manuscript and cursive. The assessment for manuscript aspect measures both handwriting legibility and handwriting speed using six evaluation tasks. These tasks resemble tasks required during classroom participation: writing the alphabet from memory, numeral writing (writing numerals from 1 to 12), copying from a near-point model (write a five-word sentence), copying from a far-point model, writing from dictation (write two five-letter non words and one five-number zip code) and composing a sentence (at least five words). The assessment for cursive aspect is a criterion-referenced handwriting assessment administered with standardized and normed scoring procedures that evaluate handwriting and speed in elementary school students. It includes the following writing tasks: writing the lower case and upper case alphabets from memory in cursive (a-z), writing numerals from memory (1–20), near-point copying (5 words, 31 letters), far-point copying (7 words, 29 letters), manuscript-to-cursive transition (6 words, 31 letters, 5 numerals),

dictation (15 letters and 5 numerals) and sentence composition (of at least 5 words). The test normally requires 15 minutes to 40 minutes for students to complete, depending on the students' written language skills, memory and speed".

The chief objective of the study was to find the effectiveness of Kinesiotaping as an adjunctive therapy to improve dysgraphia in children with hemiplegic cerebral palsy.

The study was detailed and tailored to find which mode of treatment was better in the two groups after 2 weeks of therapy, using the evaluation tool of children's handwriting. In all, 20 cerebral palsied children (n = 20, 10 males, 10 females, 8 children within the age group of 6–7 years and 12 children within the age group of 7-8 years) received the conventional physiotherapy treatment and 20 cerebral palsied children (n = 20, 14 males, 6 females, 9 children within the age group of 6–7 years and 11 children within the age group of 7-8 years) received the kinesiotaping along with the conventional physiotherapy for 2 weeks.

Pre- and post-test values of the scores of ETCH were measured before the start of treatment and at the end of the second week. These values were statistically analysed using the student's *t* test. The statistical analysis done showed that the groups taken for the study, either Group I treated by the conventional physiotherapy or Group II treated by kinesiotaping along with the conventional physiotherapy showed significance in improving the handwriting scores of the children with hemiplegic cerebral palsy.

The statistical analysis also showed that the Group II treated with kinesiotaping along with the conventional physiotherapy had higher significance when compared to the Group I, treated only with the conventional physiotherapy. These results were significant at $p = 0.009$ for the word legibility and $p < 0.001$ for the letter and numeral legibility. It strongly supports the earlier findings of Audrey Yasukawa (2006), who evaluated the effectiveness of kinesiotaping to improve the motor skills in the upper extremity of children in an acute rehabilitation program.

This study implies that conventional therapy and kinesiotaping can be used in the intervention of dysgraphia in children with hemiplegic cerebral palsy to improve the handwriting scores, but when kinesiotaping is used along with conventional therapy, the handwriting scores of children with hemiplegic cerebral palsy show significant improvement. This can be attributed to the proprioceptive and tactile facilitation, which is enhanced due to the effect of the kinesiotape.

Table 1: Age Distribution of Children Studied

Age in Years	Group I		Group II	
	No	%	No	%
6.1–6.12	8	40.0	9	45.0
7.0–7.12	12	60.0	11	55.0

Samples are age matched with $p = 0.749$

Table 2: Comparison of Legibility of Handwriting in Children Studied

	Pre/Post-test	Group I	Group II	P value
Word	Pre-test	15.00±8.69	15.00±8.69	1.000
	Post-test	33.13±7.88	40.31±8.47	0.009**
Letter	Pre-test	30.22±9.09	30.22±9.09	1.000
	Post-test	46.87±6.31	72.34±4.32	<0.001**
Numeral	Pre-test	38.49±15.21	38.49±15.21	1.000
	Post-test	49.08±11.02	76.11±6.47	<0.001**

Table 3: Comparison of Outcome (Difference of Pre and Post) in Two Groups

Outcome	Group I	Group II	P value	Effect Size
Word	18.31±8.58	25.31±6.23	0.004**	0.92
Letter	16.64±4.52	42.11±9.31	<0.001**	3.41
Numeral	10.58±7.03	37.62±14.06	<0.001**	2.38

LIMITATIONS OF THE STUDY

- The sample size in this study was small. The findings should be substantiated in a larger group of subjects.
- The long-term effectiveness of the kinesiotape is not known.

CONCLUSIONS

This study can be concluded stating that Kinesiotaping used as an adjunctive therapy along with conventional physiotherapy is more effective in improving dysgraphia in children with hemiplegic cerebral palsy as compared with therapy involving only conventional physiotherapy.

SUMMARY

"The present study is aimed to determine the effect of kinesiotape along with conventional therapy to improve dysgraphia in children with hemiplegic cerebral palsy. In this study, totally 40 children with hemiplegic cerebral palsy were selected and divided into two groups. Group I (control group) of 20 subjects received conventional therapy for a period of two weeks. Group II (experimental group) of 20 subjects received kinesiotaping on alternate days for a period of two weeks along with the conventional therapy. Data was collected at the beginning of the treatment (pre-test) and at the end of the treatment (post-test)".

"Data were analyzed using student's t test, which showed that both conventional therapy and kinesiotaping have good beneficial effects in improving dysgraphia in children with hemiplegic cerebral palsy, but when compared between the two groups for effectiveness, the results were significant for kinesiotaping along with kinesiotaping. Thus, this study accepts the experimental hypothesis. Hence, when kinesiotaping is used as an adjunctive therapy along with conventional therapy to improve dysgraphia in children with hemiplegic cerebral palsy, the improvement is highly significant".

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AUTHOR'S PROFILE



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Education: Highest formal education is Master of Physiotherapy (with specialization in Paediatrics) from Rajiv Gandhi University of Health Sciences, Bangalore in 2013. Additional qualifications include: certification by the **GM Trust** in **Early Intervention,** participation in the workshop on **Research Methodology and Biostatistics** organized by **ICMR,** got trained in the administration, scoring and interpretation of **Bayley Scales of Infant and Toddler Development,** completed

the **Basic training course on the Prechtl Method on the Qualitative Assessment of General Movements**, completed a short course on **Theory and Practice of Epidemiology and Biostatistics** (Epibio-2017), passed the **Kinesiotaping Fundamental and Advanced KT1 and KT2**, from Kinesio Taping Association International, passed **Post Graduate Diploma in Yoga** from Annamalai University, passed **Upper and Lower Quarter Mulligan's Concept Course**, from Capri Institute of Manual Therapy, passed **Diploma in Acupuncture** from Indian Acupuncture Training Centre, affiliated to Indian Integrated Acupuncture Association.

Work Experience: I have been working as a Physiotherapist in the Department of Physiotherapy from March 2000 onwards and currently hold the position of Assistant Professor in the same Department. During the course of this tenure I have published 3 articles : **Community reintegration of spinal cord-injured patients in rural south India**, published in *Spinal Cord* in 2010, **Effectiveness of sustained stretching of the inferior capsule in the management of frozen shoulder**, published in *Clinical Orthopedics and Related Research* in 2014, and **Influence of Wrist Position on grip strength in the splinted and non-splinted dominant hand** published in *International journal of Medical Science and Current Research* (available online: Vol 2, Issue 5 Page No 255-258 September – October 2019). I have also completed projects on **Effectiveness of TENS (Transcutaneous Electrical Nerve Stimulation) in labor analgesia in the first stage of labor**, (A study done on 300 patients in the first stage of labor), **Comparison of Effectiveness of TENS and Entonox in labor analgesia in the first stage of labor**, (A pilot study done on 40 patients in the first stage of labor)

I have been the **Chief resource person** for the Hands on workshop *"Physiotherapy for The Journey to Motherhood and Beyond"*, held at Rajagiri Hospital, Aluva, Kerala, on 1st September 2019



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ACADEMIC QUALIFICATIONS

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